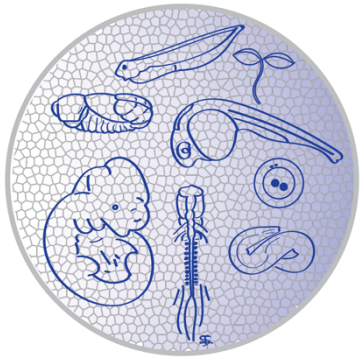
UNBIO1-034 **Developmental Biology II**



PSL Master in Life Sciences – M1 IMaLiS, ENS

Winter semester 2025 - 2026

Credits: 6 ECTS

Web site: https://www.edu.bio.ens.psl.eu/spip.php?article60&lang=fr

1. Course description

How can we define developmental biology? On one hand, it can be considered as the complex and dynamic process by which a single cell, the fertilized egg with one genome will give rise to hundreds of very different specialized cell types. These organize themselves and adopt specific forms within organs of the right size to finally give birth to an individual, impressively complex adult organism. But on the other hand, it is equally a process shaped over generations during evolution and in interaction with the environment, that led to the amazing diversity of living organisms. How this is achieved is a fascinating question. Moreover, discoveries in development biology are key to understanding diseases, including neurodevelopmental disorders and cancer, and thus have direct medical implications.

Aims: This module has the aim to introduce students to advanced concepts of developmental biology research. Leading scientists from diverse institutions in Paris, Lyon and Heidelberg will provide introductions into the background of their respective research areas. They will share insights about their exciting studies to give participants an impression of their own research as it happens at the bench. They will cover the fundamental mechanisms orchestrating morphogenesis, the emergence of multicellularity, patterning, stem cell biology, cell fate specification, cell migration, apoptosis, organ formation, regeneration, evo/devo and plant development. The course will explore the use of different model organisms, but also non-model organisms, essential to pinpointing general principles within apparent diversity. We will discuss recent state-of-the-art techniques, including Crispr/Cas9 genetic manipulations, that make it possible to find answers through the synthesis of knowledge obtained at different scales, by combining imaging, genetics and genomics and molecular biology approaches. Finally, the course has the aim to convey the notion that Developmental biology is a very active discipline at the intersection of many other disciplines that continues to transform our thinking as advances in technology are opening unprecedented doors for future studies.

Maximum class size: N/A

Language: Classes are taught in English.

Keywords: Morphogenesis | Multicellularity | Stem cells | Cell differentiation | Apoptosis | Cell migration | Patterning | Regeneration | Organogenesis | Organoids | Evo-devo | Model and non-model organisms | plant development

2. Location and time

Location: Biology Department, 3rd floor - Room **324** at the ENS, 46 rue d'Ulm, 75005 Paris.

To enter the building, an access card is required, visitors without a badge must use the intercom at the entrance. The floor and class rooms do not require a badge. The building, floor and class room are readily accessible through a ramp and elevators.

Duration: Winter semester | 39 hours in person (plus additional hours for homework assignments)

First and last day of course: from **09 September** to **16 December 2025**

Hours: **9h00 – 12h00** (13 weekly courses on Tuesday morning)

3. Course organization

Coordination: Iris Salecker (PU, Département de Biologie, ENS), iris.salecker@bio.ens.psl.eu

Preferred method of contact: email (or in person, after a convenient time has been found)

4. Registration

IMaliS students will be registered for the course by our administration. Students external to the ENS Biology Department can attend classes after contacting the course coordinator to receive approval (see contact information below). Subsequently, students will need to register online at least one week before the course starting date by following the instructions on https://www.enseignement.biologie.ens.fr/?article207.

5. Course communication

Course material: Pdf versions of PowerPoint presentations, journal club articles and other material for course work will be provided online via the **Moodle** website of the **Biology Department** (https://moodle.bio.ens.psl.eu).

Announcements will be shared: by email and Moodle.

6. Course prerequisites

There are no specific requirements to attend this module. However, participants should bring plenty of curiosity and an inquisitive mind. Some background in cell, molecular and developmental biology, as well as genetics is recommended.

7. Course format and teaching methods

A two-hour lecture of one invited researcher (or the course coordinator) will be at the heart of each of the 13 courses. Presentations will consist of a general introduction to the scientific topic and of insights into ongoing projects of the lecturer's team. These will be followed by one or two student journal club presentations (depending on the number of participants) and discussions; the articles are related to the topic of each lecture. The journal clubs will be organized ahead of the course together with the students. The course program furthermore includes a Crispr/Cas9 tutorial. To deepen their knowledge and understanding, students will be assigned four sets of course question exercises as homework, with answers to be submitted via Moodle. To conclude the learning process, students will receive feedback for each assignment at the end of the course.

For the Crispr/Cas9 tutorial, students are encouraged to bring their own laptop and install a free Molecular biology software package prior to the course. A functional wireless connection will be required to access websites with relevant information during the tutorial.

The practical M1 course UNBIO1-053 Developmental Biology at the Bench and this course would complement each other.

8. Learning outcomes

Upon completion of the course students will be able to:

- understand key concepts in developmental biology
  - how the regulation of the cell cytoskeleton and cellular migration underly developmental processes
  - how apoptosis and cell competition contribute to tissue morphogenesis, growth and homeostasis;
  - how transcriptional factors and molecular signaling pathways orchestrate body plan, organ and tissue development;
  - the importance of mechanobiological mechanisms to controlling early developmental steps and transitions;
  - the role of Physics and Mathematics for describing and probing developmental mechanisms;
  - the significance of controlling the precise timing of developmental processes, as the slightest changes can result in developmental disorders in some circumstances;
  - the underlying principles of stem cell formation, patterning and maintenance, as well as the generation of neuronal diversity in vertebrate and invertebrate nervous systems;
  - the link between stem cell regulation, cell migration and cancer;
- integrate knowledge gained from different vertebrate and invertebrate model/and non-model organisms towards the discovery of fundamental principles underlying developmental biology;
- include evo-devo concepts into their thinking;
- compare cellular and molecular mechanisms underlying animal and plant development;
- have an overview of state-of-the art technologies used in developmental biology, including genetic approaches, genomics, microscopy, cell culture and organoid approaches;
- design a Crispr/Cas9 experiment on paper to generate knockout or epitope-tagged alleles of a gene of interest from identification of PAM sites to functional validations;
- have the tools for designing experimental strategies to test hypotheses in the field of developmental biology;
- follow advanced developmental biology courses at the M2 or PhD level in the future, e.g. ABC Cell and Developmental Biology, Institut Curie Developmental Biology: From stem cells to morphogenesis and Development and Cancer;

Transverse skills

- To read and understand primary scientific literature in the field of developmental biology;
- To communicate and critically discuss a scientific paper in oral presentations to their peers.

9. Course schedule

Please find the detailed course program below.

ENS – Département de Biologie

Master IMaLiS M1

UNBIO1-034 2025 - 2026

Developmental Biology II

09/09/2025 – 16/12/2025

Coordination: Iris Salecker (iris.salecker@bio.ens.psl.eu)

Tuesdays 9h00 - 12h00, Salle 324

09/09/2025 – Introduction and Course 01		
Iris Salecker	Introduction to course (45 min)	Introduction
Nicolas David *(Ecole Polytechnique, Paris)* nicolas.david@polytechnique.edu	"Cell migrations during development"	Lecture and discussion
16/09/2025 – Course 02		
Iris Salecker *(IBENS, Paris)* iris.salecker@bio.ens.psl.eu	"Tutorial: Designing Crispr/Cas9 strategies for functional genetic approaches"	Lecture, paper presentation and discussion
23/09/2025 – Course 03		
Allison Bardin (Institut Curie, Paris) Allison.Bardin@curie.fr	"Understanding adult stem cell regulation using the *Drosophila* intestine"	Lecture, paper presentation and discussion
30/09/2025 – Course 04		
Véronique Brodu *(Institut Jaques Monod, Paris)* veronique.brodu@ijm.fr	"3D Collective cell migration: Plumbing issues"	Lecture, paper presentation and discussion
07/10/2025 – Course 05		
Stéphane Nedelec (Institut Jacques Monod, Paris) stephane.nedelec@inserm.fr	"*In vitro* models of human development"	Lecture, paper presentation and discussion
14/10/2025 – Course 06		
Sigolène Meilhac *(Institut Pasteur)* meilhac@pasteur.fr	"Left-right asymmetry of morphogenesis"	Lecture, paper presentation and discussion
21/10/2025 – Course 07		
Thibaut Brunet (Institut Pasteur, Paris) thibaut.brunet@pasteur.fr	"Choanoflagellates and the origin of animal multicellularity and morphogenesis"	Lecture, paper presentation and discussion
28/10/2025 – Course 08		
Iris Salecker *(IBENS, Paris)* iris.salecker@bio.ens.psl.eu	"A challenge of numbers and diversity: neurogenesis in *Drosophila*"	Lecture, paper presentation and discussion
04/11/2025 – Course 09		
Jean-Léon Maître *(Institut Curie, Paris)* Jean-Leon.Maitre@curie.fr	"Mechanics of blastocyst morphogenesis"	Lecture, paper presentation and discussion
18/11/2025 – Course 10		
Romain Levayer *(Institut Pasteur)* romain.levayer@pasteur.fr	"Carving tissues with apoptosis: homeostasis, growth, morphogenesis and beyond"	Lecture, paper presentation and discussion

02/12/2025 – Course 11		
Teva Vernoux *(ENS Lyon)* teva.vernoux@ens-lyon.fr	"From hormonal signals to dynamical self-organization of shoot development in plants"	Lecture, paper presentation and discussion
09/12/2025 – Course 12		
Anne-Hélène Monsoro-Burq *(Institut Curie, Orsay)* anne.monsoro-burq@universite-paris-saclay.fr	"Neural crest: evolution, development and cancer"	Lecture, paper presentation and discussion
16/12/2025 – Course 13 and Final Discussion		
Aissam Ikmi *(EMBL, Heidelberg)* aissam.ikmi@embl.de	"Shape determinants and homeostasis in Cnidarians"	Lecture and discussion
Iris Salecker	Final discussion and closing words	Discussion

10. Evaluation and grading

Assessment categories	Percentage of final grade
Course participation and punctuality	10%
Journal club presentation	40%
Crispr/Cas9 tutorial	25%
Course question exercise (3 sets)	25%
Total	**100%**

Deadline to submit Crispr/Cas9 tutorial: **6 January 2026**

Deadlines to submit answers to "Course question exercises": **Two weeks** after the questions have been provided on Moodle in four sets, but at the latest on **6 January 2026**.

Extensions for missed assignment deadlines, a possible rescheduling of the journal club presentation (only possible during the duration of the course) or other adjustments will be decided on a case-by-case basis. In exceptional circumstances, to validate the course, assignments will need to be completed at the latest by 13 February 2026 during the week dedicated to exam re-sits.

11. Recommended resources

Suggested readings during the course:

- Primary literature and articles for journal clubs will be provided via Moodle.
- Some chapters in relevant text books (Michael Barresi and Scott Gilbert: Developmental Biology; Lewis Wolpert, Cheryll Tickle, Alfonso Martinez Arias: Principles of Development; Alessandro Minelli: Understanding Development).

Special resources: Material and instructions for the Crispr/Cas9 tutorial will be provided in a dedicated document (shared as printout and via Moodle).

12. Absence, class participation and classroom etiquette

Students are expected to arrive in time, to attend all classes in person, to actively participate in and to focus on the class during the course. Students should notify the course coordinator in advance in case of an exceptional absence. Absences for health reasons require a medical certificate.

To foster a positive learning environment, students and lecturers have a shared responsibility. We seek to create a friendly, respectful and inclusive atmosphere, allowing us to immerse ourselves together into exciting science.

Disclaimer: Information contained in this syllabus may be subject to change with reasonable advance notice, as deemed appropriate by the coordinator of the course.

* Image credit: Iris Salecker

vs. 11/07/2025